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ABSTRACT

This paper reviews major stidues in metacognitive research relating to education and discusses their implications for educators and teacher education. Metacognition generally refers to self-awareness, or self knowledge of one's thought processes. Two types of research are discussed: (1) descriptive or correlational data on the natural development of metacognition; and (2) studies on the trainability of metacognition. The developmental research explores metamemory, the feeling of knowing, memory monitoring, and comprehension monitoring. The overview of training research concentrates on three program efforts using educational interventions based on metacognitive findings: (1) Ann Brown's research with the mentally retarded; (2) research on training knowledge relevant for memory of discrete items reviewed by Pressley, Borkowski, and O'Sullivan; and (3) research on the effectiveness of metacognitive training, led by Bransford and Franks. Metacognitive research has progressed from investigations of discrete skills to a theory of intelligence and intellectual development. Findings have direct educational applications. Teachers should adapt metacognitive knowledge to instructional programs and pay attention to how their students learn. More theoretically-based research is needed which links metacognition to other cognitive theories. (BS)

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What does Research on Metacognition Have to offer Educators?

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I am happy to be here today. Believe it or not the last time I reviewed an area for NERA the meeting was held at the Hotel Tenn Eich in Albany and we were all hoping I would finish before the roof fell in. I recall quite well that the review was in the area of learning and at the completion of the presentation an elderly professor asked how to spell the name Piaget -it was a name new to him. Today we are still feeling the influence of Piaget, because it is he who was a major instigator of metacognition. Although it is a 1928 Piaget reference which is often used as initial reference for the area, its history goes back to the earliest days of psychology. For instance, the method of introspection was a major procedure used by structralists and even the term mentalism has been resurrected and used in metacognition. Thus, the old procedural problems raised by the early behaviorists many years ago are again relevent, (see Cavanaugh and Perlmutter, 1982). These antecedents must be kept in mind as we proceed through the literature. This research should also be viewed as a major part of the recent emphasis on information processing. In fact, when Piaget is not cited we are generally referred to Tulving as an initiator of such research.

Because my interests during the last few years have been in other areas, I accepted the task of reviewing metacognition to increase my own knowledge of what I perceived as a relatively new area with a rather limited literature. I was wrong. Although studies including "meta" have been appearing

only in the last 15 years, we were able to locate over 225 citations. Half of these were published since 1980. The complete bibliography is available upon request. With this vast literature I would be the first to admit that I have not read all of the studies nor will I attempt to cover all I have read in the short time allotted. What I will attempt to do is cover the major studies and areas which are most directly related to education. In addition, I will indicate what I believe are the most relevant implications for educators and those directly involved in teacher education. Finally, I will suggest what I believe are directions which should be taken in metacognitive research.

Metacognition has been defined in a number of ways but most definitions include the term "self knowledge". In its broadest sense metacognition refers to the awareness one has about his/her thought processes. The labels for phenomena studied include feeling of knowing, comprehension monitoring, metamemory, memory knowledge and knowledge of understanding. By far the largest amount of research has been done in the area of metamemory.

As the area evolves, the definition changes. We believe that eventually it will be viewed as an alternative conception of intelligence. In this conception, cognition could be made up of knowledge, strategies for knowledge acquisition, information about these strategies and an executive control. Exactly how these all fit together is yet to be determined.

As passive observers, we have welcomed this line of

research as a possible extension of self concept and/or self esteem research. This is because of the emphasis in this latter line of theorizing and research has been on how to develop a positive self concept or increased self esteem. We have believed for a long time that more emphasis should be placed on a realistic self concept and acceptable self esteem. It is our contention that the type of information tapped by those interested in metacognition should form the basis for such a realistic self concept. For instance, one should not have a high self concept as a student if he/she is a mediocre student and has difficulty learning. Instead the student needs to know his/her relative strengths, including general, (e.g., I am good at reading, but poor at math), as well as more specific abilities, (e.g., I am poor at memorizing). Such knowledge should lead to rational behavior and help people plan the immediate (I will need to study hard tonight) and more extended future (I will have a better chance at being a lawyer than an engineer).

Unfortunately, this is a premature speculation. The connection between self concept and metacognition has yet to be made and interest in individual differences in metacognition has just begun in earnest.

There are obviously numerous ways in which the area of metacognition could be organized (cf. Flavell and Wellman, 1977). I have chosen to organize the area into two broad categories. The first contains descriptive or correlational data which attempts to specify how metacognition develops

naturally. Results from this research are used to answer educational questions regarding what has been termed readiness (e.g., are memory skills developed well enough so that reading training can begin?). Adult or aging research using this strategy is concerned with how well these abilities are maintained throughout life, (e.g., does feeling of knowing remain accurate throughout life?).

The second category of research concerns the trainability of metacognition. Researchers have attempted to train both very specific (e.g., categorization in free recall) and very general abilities (e.g., entire reading programs). Some (e.g., Taylor, 1983) have even suggested that metacognitive training should become an integral part of the curriculum. A major area of concern in training studies has been how to acquire generalizability of specific training. Obviously the two areas of research (those interested in natural development and those interested in training) are not mutually exclusive and to a certain degree complement each other. For instance, if retarded or learning disabled children are deficient in metacognition should remedial training include instruction in metacognition? We would maintain however, that most of those interested in the natural development of metacognitive abilities have a different view about human cognition and its development than those interested in training. More specifically, those studying the natural development would be pessimistic about the utility of training and believe their findings would be more relevant for educators by supplying

teachers with normative information about what children at different levels are able to do. Those interested in training are less maturationally oriented and would be optimistic about accelerating development. It is an old controversy perhaps best represented by Gesell and Piaget versus Skinner and Gagne. The questions are "Ready or not?" versus "Ready for what?" Because of this interest in readiness and the assumption of most theorists that important cognitive changes occur between 5-7, the vast majority of these studies deal with nursery school and/or elementary school children.

Metacognitive research designed to determine the nature and course of its development

Metamemory in general

Although there were a number of studies prior to its appearance, the most frequently cited study in the area of metamemory development appeared in 1975. Kreutzer, Leonard and Flavell published an SRCD monograph entitled "An interview study of children's knowledge about memory." In this study 80 middle-class boys and girls (20 at K, 1, 3, and 5) were interviewed on a wide variety of topics in order to determine what they knew about memory. The interview (parts of which have been used by numerous other researchers e.g., Cavanaugh and Borkowski, 1980) was divided into 14 parts. It assessed personal knowledge about the child's own memory (e.g., Do you remember some things better than others?) as well as information about how the human memory system works in general. Knowledge tapped included methods of saving (e.g., is

relearning more rapid than initial learning?), immediate vs delayed learning (e.g., If you were given a phone number would you use it immediately or get a drink first?) and study-strategy information (e.g., Is it easier to recall items by themselves or as part of a story?). Other items covered the influence of study time or having a study plan on recall, ways of preparing for recalling an event or a task, ways of retrieving events or objects, colored versus uncolored pairing, opposites versus artibrary, and finally, questions about phenomena studied by learning psychologists (retroactive interference, rote versus paraphase recall). These latter questions were generated to determine children's awareness of memory as depicted by introductory psychology texts (specifically Dember and Jenkins, 1970).

Reading the results of this monograph is time consuming and the specific findings are not that impressive. As everyone would expect the third and fifth graders were able to correctly answer more questions than the younger children. The major differences occurred on questions requiring long answers or explanations. For instance, there were minimal age differences in the number of children who knew that they forgot things but significant age differences in types of strategies the children could suggest for recalling things. Reading the summary of the findings resulted in very little in the way of specific generalizations. The major impact of the monograph was to define the area of metacognition and stimulate future research. In addition, there were a number of weaknesses which also still

permeate the area.

Besides the usual difficulties associated with introspection (e.g., one must understand the questions in order to answer and the authors indicated that some of the younger children probably did not understand the questions), the authors were unable to satisfy many of the standard psychometric properties with their interview. There were no data on the internal consistancy of the tasks. The authors did attempt to use a X^2 contingency analysis of the data on some of the tests (e.g., preparation event with retrieval event) to look at consistencies across tests. Obviously, one might predict metamemory performance on these two tasks would be related. They did not find evidence favoring consistency of individuals across events but state "However, it would surely be unwise to conclude anything from these analyses as regards possible interrelations among items of mnemonic knowledge" (p. 49). To our knowledge, few authors have directly addressed the issue of relibility or consistency of metamemory performance across tasks. Kurtz, Reid, Borkowski, and Cavanaugh (1982) report test-retest reliability for 55 second graders on four of the Kreutzer et al. interview items (story list, preparation object, retrieval event, rote paraphrase) along with a memory monitoring task ("ability to adjust recall estimates based on prior recall experience," p. 138), a measure of awareness of the role of familiarity in allotting study time, and a serial recall task designed to measure the ability to match output demands with input strategies. The test-retest reliabilities

using converted Z scores were quite low, ranging from .13 (the serial recall task) to .49 (retrieval-event). The test-retest reliability for the total battery score was only .67.

The correlations among subtests were also quite low. The memory monitoring task did not correlate significantly with any other subtest. There were three significant intercorrelations among the four tasks from the Kreutzer et al. interview. Story list did not relate to the other original measures. Three of the original subtests did correlate significantly with the total test. Cavanaugh and Borkowski (1980) gave kindergartners, first, third and fifth graders the Kreutzer et al. questionnaire. They also found few significant within grade correlations among the subtests. They did find significant correlations among performance measures. Thus, one could conclude that intercorrelations between areas of memory performance emerge before areas of memory knowledge.

In summary it is obvious that researchers need to be more responsive to the psychometric properties of their tests. Certainly, increasing the number of items, clarificatioon of scoring and other revisions could markedly improve the measures typically used.

One of the weaker characteristics of the monograph and metacognitive research in general is that it is largely empirical in nature with little or no theorizing. Thus, even though Piaget is frequently mentioned as being important in stimulating metacognitive research, we have yet to see any research which attempts to link metacognitive knowledge with

any cognitive stage or Piagetian theory in general. In fact, Whitehurst in his critique of the Flavell, Speer, Green and August (1981) monograph mentions Piaget's omission and indicates "Piaget, whose stage theory is in the pedigree of all modern work on children's communication, is not mentioned or referenced once in the entire Monograph " (p. 62).

Without any theory guiding the research there is little basis on which to predict which metacognitive abilities should be significantly related. It is almost as if the researchers believe that metacognition is a set of discrete tasks which appear independently. In this context, it is disappointing to find that the very researchers who published the low intercorrelations among metacognitive subtests arbitrarily combined such subtests to obtain a total metamemory score in later research (e.g., Kurtz and Borkowski, 1984).

Another issue which was not addressed by Kreutzer et al. concerns the relationship between metacognitive knowledge and performance on relevant tasks. Although most researchers seemed to originally assume that metacognitive knowledge (e.g., the description of a strategy) will preceed or accompany use of the knowledge (e.g., demonstration of the strategy) this has often not been the case. In fact there have been numerous studies in which no relationship has been found between metacognitive knowledge about a task and performance on that task (e.g., Cavanaugh and Borkowski, 1980). The nature of this relationship remains unresolved and probably varies with the task. There are of course severe methodological problems

associated with this question. Metacognitive knowledge is often retrospective and also vulnerable to demand characteristics of the experiment.

Since the Kreutzer et al. interview, research in this area has tended to focus on individual metamemory abilities. The following sections attempt to summarize findings for three of the more prominent areas, 1) feeling of knowing, 2) memory monitoriing, and 3) comprehension monitoring.

Feeling of knowing

The phenomena labeled feeling of knowing or tip of the tongue phenomena has been in the literature for a number of years. It is usually discussed in memory books (e.g., Baddeley, 1976) as evidence that we know more than we can recall. More specifically, the information is stored but inaccessable at the time of required recall. The initial study most often cited was reported by Hart (1965) who questioned subjects on topics of general information. When subjects failed to provide answers they were asked to indicate how confident they were that they really knew the answer (i.e. that it was stored in memory). On a subsequent recognition test, subjects were more accurate in correctly choosing those items they felt they knew. Brown and McNeil (1966) read definitions of obscure English words and asked their subjects to identify the word. They found that at times subjects who could not produce the word believed the word was "on the tip of their tongue". Occasionally they reported a number of characteristics of the correct word. Further studies have

verified that the phenomena exists (Yarmez, 1983) and characteristics such as number of syllables or initial letter are often available when the answer is not. Originally, the findings in feeling of knowing research were used to help describe the organization of long term memory. Currently, proponents of metacognition use the feeling of knowing phenomena as evidence that a monitoring process exists which automatically alerts the subject to the fact that information is available in memory which cannot be immediately accessed. Interest revolves around the development and maintenance of this process throughout the life span.

One of the most provocative studies in this area was completed by Wellman (1977). He asked Kindergarten, first, and third graders to name objects depicted in line drawings. Drawings were chosen on the basis of difficulty determined by performance of a pilot group. Therefore, actual items varied across age but were equated for difficulty (essentially they were easy, medium difficult and difficult). Subjects went through all items and then items which the subjects initially failed to name were presented twice more. On one presentation Ss were asked if they believed they would recognize the name of the object if they heard it (feeling of knowing judgment) and on the other presentation they were asked if they had ever seen the object before (seen judgment). Trials were counterbalanced so half of the subjects made seen judgments first and the other half feeling of knowing judgments first.

Finally, the experimenter presented sets of 9 pictures and

one correct name for each of the objects. Subjects were asked to point to the object named. This was the recognition score. Note that the feeling of knowing judgment was made on whether or not the subject would recognize the name and the recognition score was made on recognizing the object when the name was presented. Since all judgments were yes-no, phi coefficients could be computed between judgement (seen and feeling of knowing) and recognition scores.

The finding of importance was that older subjects were more accurate in their feeling of knowing judgments than the younger subjects (phi coefficients were (K=.19, 1=.35, 3=.60). However, there were no grade differences in the relationship between seen judgments and recognition (K=.44, 1=.48, 3=.56). As one would expect the relationship between seen and feeling of knowing judgments were also higher for the older subjects.

The authors suggest that the information necessary for younger children to make an accurate feeling of knowing judgment was present in memory but not utilized. This could be because the process necessary to alert the subject that the answer was known had not yet developed. This process when developed would automatically access the related material necessary for making the accurate feeling of knowing judgment. Although there are obviously alternative explanations of these data (e.g., the younger children do not think to access the relevant information) and additional research is necessary, this is some of the better evidence presented to support the contention that it is a process which is developing.

Once the accurate feeling of knowing ability has developed, Lachman, Lachman and Thronesbery (1979) have presented evidence that it is maintained throughout the life span. Using unknown items on trivia questions they were able to compare the performance of three age groups (19-22, 44-53, 65-74) on accuracy and expenditure of search time (metamemory efficiency). They concluded that there were no developmental changes in performance on this skill from ages 19 to 74.

One other study in this area deserves special mention. Nelson, Leonesio, Shimamura, Landwehr, and Narens (1982) attempted to shed light on the experiential antecedents of the feeling of knowing. Fifty college Ss learned number noun pairs to the criterion of 1, 2, or 4 correct responses. Four weeks later the Ss were again presented with the number stimuli. For those items which the Ss failed to recall correctly, two correlated feeling of knowing judgments were acquired. One used ranking of items (relative feeling of knowing) and the other resembled Hart's procedure (absolute feeling of knowing). Finally, a four alternative forced choice recognition test was given for nonrecalled pairs.

They found that degree of overlearning was significantly related to both recall retention and feeling of knowing for nonrecalled items. Item difficulty (number of trials before a correct response) was not related to feeling of knowing. Thus, for adults we can say that at least one antecedent of feeling of knowing is overlearning.

There are two rather explicit educational applications

which flow from these data. First, the latter study supports the importance of overlearning when long term retention is desired. Further research using overlearning with more meaningful material would probably provide additional information about how connections with other knowledge in long term memory are formed. This could be done in the context of schema theory.

The second application is in the area of testing. It seems to me that if the teacher wants to learn what the student knows then recognition tests should be used. If the teacher wants the students to know the material particularly well then recall tests should be employed. One area of potential research would be to determine the influence of anxiety on recall. Perhaps anxiety interferes with recall but not feeling of knowing.

Memory monitoring

We have used the term memory monitoring to include studies which measure the subjects' ability to predict their own performance on tasks requiring memory of discrete items. Such studies often also include measures of subjects' understanding and/or spontaneous adoption of strategies. Occasionally the possibility for adoption of a strategy is provided by the organization of learning materials.

Flavell, Friedrichs and Hoyt (1970) reported one of the initial studies in this area. They were interested in the ability to predict ones own memory span and determine when material was learned well enough to be perfectly recalled.

Subjects included nursery school children, kindergartners, second and fourth graders. They were initially provided with strips of pictures and asked to predict the maximum number of objects (10 per strip) they would be able to recall in sequence. Next, their actual object span was assessed in the manner used to traditionally assess digit span forward (using familiar object names instead of numbers). Finally, children were presented with three sets of pictures (the number of pictures equalled the S s object span) and told to look at the pictures one at a time until they were "sure" they knew them all in order. Recall performance (immediate and delayed), study time, and study strategies were recorded.

The major finding was that as age increased object span increased and predicted object span decreased. The mean predicted span of nursery school children was 7.2, while their actual mean object span was only 3.5. These same means for fourth graders were 6.1 and 5.5.

Similar results were obtained for the recall readiness data. Older children (2nd and 4th graders) took more study time, were more accurate in determining that they were ready to recall perfectly, and spontaneously engaged in more mature study strategies such as, rehearsal (e.g., naming objects in sequence) and gesture (e.g., finger coounting, head nodding). These results were replicated some time later by Yussin and Levy (1975).

From the results of such studies we might conclude that younger children have no conception of their own memory

limitations, and probably do not comprehend those variables which influence memory performance. This generalization has been called in to question by the results of a clever study reported by Wellman, Collins, and Glieberman (1981). They presented preschoolers, second graders, fourth graders and college Ss with 9 pictures. Each picture contained variations of two memory performance variables; effort (a student was pictured seated at a desk applying varying degrees of effort to a memory task), and number of items (4, 8, or 12 items were present to be memorized by the student in the picture). Ss were asked to predict the number of items which the pictured S would be able to recall when exhibiting varying degrees of effort. They found that even the youngest children understood the importance of number of items and effort in recall. The major age difference was that young children emphiasized effort over the number of items. This should not be too surprising since there is so much emphasis in our culture on the belief that effort can overcome all obstacles. It is only after experience that children became aware of the importance of task demands. Thus, children in this study were able to comprehend the important variables for a hypothesized student, while in earlier studies students of the same age had difficulty predicting their own behavior.

Another task which fits somewhat better into the goals of this research is free recall. Here it is possible to observe strategy use during study or encoding as well as infer storing strategy from recall. The initial study was reported by Moely,

Olson, Halwes, and Flavell (1969). They used kindergarteners, first and third graders to investigate development of spontaneous clustering to aid recall. Subjects were presented pictures of common objects belonging to four conceptual categories. Subjects were divided into three groups. The control group was asked to identify each picture and was then instructed to study the pictures which were arranged in a random order. A naming group was additionally provided with labels for the categories. A treatment group was asked to actually sort the items into categories. There was also a fifth grade control group.

Measures were taken of clustering during study and recall. Behaviors during study and recall were also tabulated. There was no significant spontaneous clustering during study or recall in any control group below fifth grade. This finding was replicated in a subsequent study reported by Neimark, Slotnick and Ulrich (1971). The naming condition produced clustering for third graders only. Clustering appeared in the teaching condition at all ages. Thus, for cluster scores there were significant condition by grade interactions. This was not true for recall scores, however, implying that experimental stimulation of clustering increases recall independent of age level.

Moynahan (1976) later compared first and third graders on their ability to estimate the number of line drawings they had recalled on categorized and noncategorized lists. She found that third graders were more accurate than first graders,

overall both groups were more accurate in their estimates of recall of categorized lists and boys were more accurate than girls. Thus, even the youngest group was aware of their recall performance.

Salatas and Flavell (1976) used only first graders but added to these findings. On a free recall task they found that "remember" instructions produced more strategic behaviors (external behaviors used to infer metamemory knowledge) than "look" instructions. They also found Ss in the remember condition recalled more items and provided more evidence of "spontaneous" categorization during the 3 study-recall trials. Categorization actually increased on a retest 6 weeks after original recall. This later categorization was only related to spontaneous clustering during the third recall trial. The interesting finding concerned answers to what the authors termed metamemory questions. Ss were asked which of 2 lists would be easier to memorize (grouped array vs. mixed array). Correct answers on the metamemory questions about the facilitative effect of category grouping were frequent, but unrelated to previous categorization on the free recall trials. Although Ss who had "remember" instructions were more likely to answer metamemory questions correctly, metamemory did not predict retest categorization.

These former studies measured use of strategy (categorizations) but not verbalized reasons for using the strategy. However, it is the knowledge of a strategy and its effects which authors often refer to when they use the label

metamemory. Moynahan (1973) attempted to measure such metamemory knowledge on a rather complicated design using a free recall task with 1st, 3rd, and 5th graders. Subjects were divided into four groups. All groups were presented with 11 sets of 2 cards (one card per set contained 4 objects in each of two categories and the other contained 8 separate noncategorizable objects). All subjects were asked to judge (predict) which card would be the easiest to recall. After all predictions had been recorded the S s were asked to justify their predictions. The groups differed in the order of presentation (prediction-recall, recall-prediction) and two other pre-prediction treatments (naming and sequencing tasks). All grades predicted categorized cards would be easier to recall but third and fifth graders were more apt to make such a prediction than first graders. This same trend was found with explanation scores (greater number of correct explanations for third and fifth graders).

The results of a study reported by Kelly, Scholnick, Travers, and Johnson (1976) served to complicate matters further. Stimuli were decks of cards containing 8 lists of items taken from a single category. List items varied in number from 3 to 12. These were placed face down in front of kindergartners, first graders and fourth graders. Subjects were then asked to place identical decks down in the same order (recall) and predict which were correctly placed and which were not. Groups differed on when the predictions were made (before or after recall) and whether they predicted on single cards or

the entire list. Although there were age differences in recall (older recall more), there were no significant age effects on accuracy of prediction. Subsequently, a college group was added and still no differences among groups in prediction accuracy were found. Thus, recall and judgment of recall accuracy were unrelated.

In a second study these same authors had kindergarteners through second graders and adults judge what they had recalled after performing on a supraspan list. Subjects then studied the list until they believed they could recall it perfectly. The authors report, "Although adults and children were equally accurate in their initial estimates of recall, adults used that information more skillfully in choosing what to study and deciding when they had studied sufficiently. Skill in memory appraisal was unrelated to recall readiness, absolute level of recall, or choice of strategies for studying" (p. 648). This data suggests that children know how accurate their recall judgments are (possibly a feeling of knowing ability), yet lack strategies for increasing recall.

Finally, Fabricuis and Hagen (1984) recently reported a rather unique study in which first and second graders were provided an opportunity to incidentally sort items into categories before recall. These children were then asked if they sorted items in any special way. During an intentional learning trial children were told to sort pictures in a way to help them remember. They were then asked what affected their recall. Subsequently, they were required to recall a

noncategorizable list and asked why it was more difficult than the earlier lists. In a second session children were given a standard study recall session. Children who attributed sorting to increased recall also tended to attribute the greater difficulty of the noncategorizable list to their inability to sort items into categories. They were also more likely to sort the lists during study in the second session and as a result increase recall. The authors believed this retrospective technique (having children make causal attributions about memory performance) should be adopted in future research.

In summary it appears that while spontaneous use of strategies (e.g., clustering) may occur at very early ages there is also a clear developmental trend. In addition, there is contradictory evidence concerning the relationship between strategy use and awareness of strategy effectiveness. It is our belief however, that teaching this relationship will have educational benefits.

Comprehension monitoring

Comprehension monitoring is an area distinct from memory monitoring because it refers to the subjects' ability to comprehend meaningful material. There are several types of research which can be included under this heading. The first includes studies in which subjects are provided with confusing and/or incomprehensible information and the experimenter attempts to determine whether or not the subject notices and/or can identify the problem.

In 1977 Markman reported two studies in which children in

grades one through three were provided incomprehensible verbal instructions for a game and magic trick. Ten probes were then used to determine the degree to which the children were aware of the incomprehensibility. She found that third graders became aware before first graders and that the magic trick was easier than the game. In order to increase the subject's awareness of the incomprehensibility, a demonstration condition was added in a second study. Here again there was a grade effect but no condition effect. The younger children still failed to note the incomprehensibility of the instructions.

In 1979 Markman reported a second series of 3 studies in which children were presented with essays containing obvious inconsistencies. In the first study, third, fifth and sixth graders were presented with one of two sets of three essays. The sets differed in that inconsistencies were explicit or implicit. The inconsistencies in the implicit essays were easily identified by 14 college undergraduates. After subjects had read the essays, a series of probes were presented to determine the degree of recall and how much additional information had to be provided before the inconsistencies were identified. She found a significant condition effect (implicit more difficult than explicit) but no significant grade effect. Almost half of the children failed to note the inconsistencies in at least two of the explicit essays after seven probes (only one S noted any inconsistency in more than one essay in the implicit condition).

These findings led to a second study in which half of the

children were asked to verbally repeat the entire essay, while the other half were asked to repeat the inconsistent sentences. Contrary to the prediction that repeating the 2 incompatible sentences would increase detection of inconsistency, there were no significant condition effects. Finally, in a third study a condition was added in which children were told "There is something tricky about each of the essays. Something which does not make sense. Something which is confusing. I would like you to try and spot the problem with each essay and tell me what it was that did not make any sense" (p. 651). Although these instructions improved the performance of sixth graders in both implicit and explicit conditions, the majority of third graders in the informed condition still failed to discover the inconsistencies on at least 2 essays.

Flavell, Speer, Green and August (1981) followed up this work with a detailed observational study of kindergartners and second graders. Subjects were placed in an observational room with a tape recorder and blocks. The recorder contained instructions from a child for building 23 structures 16 of which were presented with a variety of comprehension and execution problems. After each structure had been completed the S was asked if (1) the structure was like the one described on the tape and, (2) the instructions were adequate. All sessions were taped and rated in detail. The general findings were that second graders were much more apt to behaviorally indicate that the instructions were inadequate (e.g., look puzzled) and respond appropriately to the two

questions. Because the study was essentially non-theoretical no particularly insightful statements were made about the antecedents of the failure of kindergartners to locate discrepancies. The authors simply suggested six possible reasons for children to fail in comprehension monitoring and seemed to conceive of the ability as a set of discrete skills.

The most common behavior young children exhibited when a discrepant direction occurred was a "brief 'flicker' of problem detection while listening and building" (p. 36). This led the authors to suggest that the organism provided a clue but the child thereafter ignored it. They say, "The younger children do not realize the meaning, significance, and implications of the transitory feelings of puzzlement, uncertainty, etc. that they may experience during the building period" (p.56).

There are obviously educational implications for the above findings. Teachers should spend time determining the degree to which their instructions are understood. If further research using more ecologically valid settings continue to find such a low level of comprehension, educational interventions should be planned and implemented. However, we believe situational variables may prove to be crucial and if the environments investigated have greater ecological validity, younger children will be more accurate in their comprehension monitoring.

Comprehension monitoring has also been explored in a set of studies in the area of reading. No doubt there is a vast amount of reading literature which could be classified as metacognitive, however, we have limited ourselves to briefly

mentioning three often cited studies in the area. They should serve to provide the listeners with some idea of the large variability of such research.

Brown and Smiley (1977) had third, fifth, and seventh graders along with college Ss rate importance of the linguistic units of passages. They found that only college subjects were clearly able to differentiate among four levels, while third graders were unable to distinguish between the importance of any unit. Although amount of recall varied with age, proportion of recall for all ages was directly related to the rating of importance by college Ss (more important units were most often recalled by all Ss). Once again it appears that at least in some situations performance preceeds metacognitive knowledge.

Doctorow, Wittrock, and Marks (1978) conducted a study using sixth graders. Five groups differed in the degree to which they received generative instructions (write a sentence about what happened at the end of each paragraph) and retrieval cues (one or two word paragraph headings). As predicted those using both elaboration and retrieval cues exhibited greater recall. Thus, the use of metacognitive knowledge increases recall.

Hale (1983) tested the metacognitive awareness of these Doctorow et al. strategies. He had high school students read a passage. Some took notes and some simply read. Groups of students were asked to predict how well they would recall the material one, eight and fifteen days later. In addition they

were asked how much the strategy they did not use (either reading or note taking) would have affected their recall, yet students predicted significantly more forgetting than actually occurred. Note taking improved immediate but not delayed recall. Students did not believe note taking would facilitate recall. These findings are somewhat surprising because they indicate older children are quite inaccurate in predicting their own recall of meaningful material (a metacognitive ability) and don't believe note taking will facilitate recall (metacognitive knowledge).

A final study concerning metacognition and reading was reported by Myers and Paris (1978). It was designed to acquire metacognitive knowledge rather than reading comprehension. Also, it provided a clear statement about the authors belief concerning metacognition, "The general knowledge that guides effective selection and implemamntation of task relevant skills has been referred to as metacognition. It is regarded as a 'higher' level of thinking than task specific strategies because metacognitive knowledge constitutes transituational information about the parameters of learning and performance. Metacognitive knowledge serves an executive function of coordinating and directing the learner's thinking and behavior" (p. 680). A third characteristic of this study is that the results helped provide a foundation for one of the few attempts to develop a reading curriculum explicitly including metacognitive knowledge. This program will be discussed later.

Myers and Paris gave second and sixth graders a questionaire to determine their metacognitive knowledge about reading. The organization of this questionaire was adopted from Kreutzer et al. and included questions about person (e.g., what makes a good reader?) task (influence of length and content of a story) and strategy (e.g., how do you resolve comprehension failures?) variables. They found the predicted development trend; older children reported more strategies than younger children and were more accurate in coordinating specific strategies with particular task goals.

Training Research

Obviously, the usefulness of cognitive research for direct educational application would be greatly enhanced if there was strong experimental evidence showing that training in metacognition resulted in important learning gains. Such research is expensive and faces the same problems of all intervention research (e.g. often use of only one teacher, nonrandom assignment of treatment groups, short term treatments on relatively unimportant skills with lack of long term follow-up, etc.) In addition, it is often difficult to separate the metacognitive part of the training from the total training package. For instance, if you provide a strategy training session and information on when to use this strategy, the fact that the strategy improves performance may not be directly relevant for metamemory. The important finding would be if the student spontaneously uses the strategy in a different but appropriate situation. However, generalization

may be confounded by experimental procedures such as use of the original training experimenter for the generalization task and/or use of a generalization task that is quite similar to the original task.

Rather than review all of the individual training studies, we have decided to concentrate on three programmatic efforts using educational interventions based on metacognitive findings. In general, these researchers consider metacognition in a manner we described in the introduction. That is, metacognition includes knowledge, strategies and an executive control which serves overseeing and management functions. It is the belief of these researchers that all "types" of metacognition must be trained but for transfer to take place the executive function must be modified. Some (e.g., Campione, Brown, and Ferrara, 1982) would contend that the executive function is "more central to the notions of intelligence" (p. 434). This position is bolstered by the fact that most successful learners have spontaneously acquired the specific knowledge and know when to use it (see the section on Bransford and Franks). It should also be mentioned that metacognitive training does not happen in a vacuum but must be accompanied by formal instruction on specific strategies and in some cases experience with the strategies before real progress can be made. Researchers who have attempted to train only metamemory (e.g., Kurtz and Borkowski, 1984) have failed to find training effects.

The first program of training research comes from Ann

Brown's work. Although she has worked with many subject populations she is particularly known for research with the mentally retarded. As just stated, it is the belief of those who work in the laboratory that a crucial problem for the mentally retarded lies in executive functioning. They admit that the data are limited but base their argument on the importance of executive functioning on four main points "(a) Retarded children manifest deficiencies in executive functioning; (b) executive functioning is a mediator of transfer; (c) retarded children manifest deficiencies in knowledge about cognition; and (d) knowledge about cognition is less likely to be a mediator of transfer" (p. 434). In addition, there is a developmental element in their research in that training only seems to be effective with older retarded youngsters.

An article authored by Brown and Barclay (1976) can serve as an example of this work. They divided 66 mildly retarded youngsters into two groups labeled young and old on the basis of classroom assigned. The purpose of the study was to determine if retarded children could be trained to use a memory strategy. The metamemory task was to accurately indicate when the subject had learned items in order. The design included pretest, training and three post tests. The entire study took seven days and was completed over several weeks. Subjects were assigned to label, rehearsal and anticipation groups. The latter two were mnemonic strategies which should improve performance. Both age groups in the mneumonic conditions did

improve dramatically on an immediate post test. On a delayed post test however, only the older group maintained its superior performance. The interesting finding was that the younger group seemed to continue using the strategies but their accurate performance decreased. They had forgotten how the strategy worked.

The second program of research has recently been reviewed by Pressley, Borkowski, and O'Sullivan (1984). Their general interest has been in training knowledge relevant for memory of pairs of discrete items (e.g., P.A. tasks). It is their belief that the more people know about strategies the greater the probability they will use the appropriate strategies in the appropriate situations. They believe that while the relationship between metamemory and memory may be relatively low for rather easy tasks, as the tasks become more complex the relationship between metamemory and memory will increase (this may be due to the appropriate use of the executive function).

Pressely et.al. suggest a classification system for metamemory acquisition using the labels Laissez-faire, Explicit Provision of Metamemory and Metamemory Acquisition Procedures. As one might expect, these are arranged in a hypothetical heirarchy.

To illustrate the Laissez-faire approach (acquisition of metamemory strategies through insight into their use during application to memory tasks) they cite Pressley, Levin and Ghatala (in press). Their data suggest this approach (which requires little provision for explicit metamemoty information)

is more appropriate for adults. At the least they believe a Laissez-faire appproach is educationally ineffecient.

To illustrate their Explicit Provision of Metamemory category, Pressely et al. cite a recent study by O'Sullivan and Pressley (in press). Experimenters provided fifth and sixth graders with memory tasks (word pairing and Latin vocabulary definitions). Experimental groups differed in the amount of practice they received and amount and type of information provided about the utility of the keyword method for recalling pairs of words. Pressley et al. summarize by saying "In short, adding the general utility information to the memory strategy instructions increased the frequency of generalized mnemonic use and recall" (p. 101). Thus, both experience and metamemory knowledge are important antecedents to strategy use. They cite the SQ3R study method as an example of an all purpose strategy which needs to be presented with more metamemory information to increase its use.

Their highest category is <u>Metamemory Acquisition Procedures</u> . In their view children must be taught to acquire their own metamemory knowledge. The study they cite was authored by Lodico, Ghatala, Levin, Pressley and Bell (1983). This is a creative but rather complicated study, using second graders. The subjects initial training consisted of suggesting that there were many ways to play a game and in order to play games well "they must select the method that allows them to do better" (p. 267). They were then given practice in selecting the better of two methods for drawing circles and remembering a

list of letters. Control subjects spent a comparable amount of time playing games with an experimenter (practicing the same strategies as the experimental group, but receiving no feedback on their value).

Next, experimental and control subjects were given experience using two strategies to learn paired associates or two strategies to learn a free recall list. They were then asked to determine which strategy was better and indicate why. Finally, a new trial was presented and children had to decide which strategy to use. The treatment was designed to enhance metamemory acquisition (e.g., determine which strategy was better and to use this strategy later).

The mean recall of the experimental and control groups on the initial lists should not be different because both groups were provided with the same strategies. However, the experimental groups recalled significantly better than the control group. In addition, both groups were equally adept in assessing which strategy was most effective. It was in the attribution of effectiveness, selection of strategy for learning the additional list and rationale for this selection on which the experimental and control groups differed. Thus, the initial training in how to choose a game strategy resulted in metamemory knowledge acquisition and use. The authors believe "The study therefore provides direct experimental support for the presumed relationship between metacognitive knowledge and subsequent strategy use" (p. 263).

The area of training pursued by this group of researchers

is creative and directly relevant to specific learning tasks (e.g., foreign language). The major problem, however, is that the memory tasks used are limited to discrete items rather than meaningful discourse.

Paris and Cross (in press) have reported a reading intervention study in which the treatment included a large metacognitive component. The training program was based on findings in cognitive developmental psychology and incorporates strategies developed from other metacognitive research (e.g., Palincsar and Brown, in press). The authors selected two aspects of metacognition from which they constructed the treatment. The first they call knowledge about cognition and it includes declarative, procedural and conditional knowledge. "Declarative knowledge is propositional and refers to 'knowing that,' for example, War and Peace is difficult to read or making a chapter summary can aid recall" (p. 6). Procedual knowledge refers to "knowing how to perform various strategies such as skimming" (p. 6). Conditional knowledge is characterized by knowing when and why to use various strategies. The second aspect of metacognition determines which cognitive skills are used. This would include such higher-order processes as "an individual's evaluation, planning and regulating activities" (p. 7).

The training package was labeled "Informed Strategies for Learning" (ISL) and was designed to increase reading comprehension. The strategies of teaching included direct instruction, group activities, bulletin board displays which

used metaphors to justify content and teacher handouts (application of instructed strategy). The 14 weekly Modules were presented to two third and two fifth grade classes during a special training period and augmented regular classroom reading instruction. The two third and two fifth grade control classrooms received the same amount of time from the experimenter which was spent on activities requested by the regular classroom teacher.

The evaluation was designed to measure reading comprehension as well as different degrees of generalization. Pre and post test measures of reading comprehension included two standardized tests. In addition, there were two measures constructed by the experimenters. The first was a cloze test in which every fifth word was deleted from a passage, to be appropriately filled in by the Ss . The second was an error detection task designed to measure comprehension monitoring. Finally, there was a 20 item multiple choice test designed to measure comprehension of ISL.

The results were quite interesting. There were no significant treatment effects for the standardized measures but the treatment groups scored significantly higher on the other three measures, thus the treatment taught the ISL strategies, improved comprehension monitoring and performance on the cloze technique but did not improve comprehension on the standardized measures. Although a number of interpretations could be made, it is obvious that the experimenters expected overall comprehension to improve and it did not.

A major methodological problem was in determining which component of the training was responsible for treatment effects. It is possible that the metacognitive component had no effect. At any rate the research on the ISR will continue and this follow up research should serve to answer important questions about the trainability of metacognitive abilities and the effect of such training on reading comprehension.

The final research program designed to determine the effectiveness of metacognitive training was under the leadership of Bransford and Franks at Vanderbilt. Their research follows from a long term programmatic effort. The specific studies to discuss (Bransford, Stein, Vye, Franks, Auble, Mezznski, and Perfetto, 1982, Stein, Bransford, Franks, Owings, Vye, McGraw, 1982, Franks, Vye, Auble, Mezznski, Perfetto, Bransford, Stein, and Littlefield 1982; Stein, Bransford, Franks, Vye, and Perfetto, 1982) appeared in a single issue of Journal of Experimental Psychology: General. In our opinion they represent what a carefully planned set of studies should look like.

Bransford et al. (1982) indicated that their basic goal was to "Identify cognitive activities people use when trying to understand new information and account for differential success" (p. 39). The strategy was to initially determine differences between successful and less successful learners and then determine if the less successful learners could be trained to improve their performance by learning to use the activities of successful learners. In our view, the idea of studying the

successful to learn about how efficient learning is accomplished is an excellent one. It even increases in value if it is determined that the results can be employed to train less successful students.

The series of studies employed fifth graders but included findings acquired from previous research with adults. The first set of studies determined that when studying for recall more successful students produced what the authors have labeled "precise elaborations" whereas less successful students did not. These elaborations clarify and evaluate material to be memorized and can be reliably identified. In addition, much more material is recalled when it is included in such an elaboration. This is true for both successful and unsuccessful of students. The first training study found that mere prompting of less successful students did not result in increased precise elaboration. Thus, more elaborate training was instituted. Training contained three basic components (1) prompting to notice which sentences were difficult, (2) encouragement to note arbitrariness of sentences read during acquisition, (3) prompting students to "activate knowledge" that would make relationships within sentences less arbitrary. This training resulted in a significant increase in precise elaborations and recall.

The second set of studies was more directly related to metacognitive knowledge. The initial study was conducted to determine the degree to which successful and less successful fifth graders could judge the difficulties of arbitrary and

less arbitrary material. Ss were also given a cued-recall test for target adjectives after each rating task. This study resulted in the expected finding that successful students were more likely to correctly identify the difficult sentences, as well as recall more target adjectives. These differences in identification and memory actually increased for successful students across trials. The second training study once again resulted in the less successful students being more able to use arbitrariness of information in judging difficulty, subsequently improving memory.

The final set of studies utilized relatively complex passages, requiring generation of elaborations. The first study showed that less successful students failed to note differences between explicit (nonarbitrary) and implicit passages. Thus, they failed to vary time spent or study strategy with passage type. Successful students on the other hand noted the differences and varied their behaviors accordingly. This resulted in no differenes in recall for explicit passages but large differences for implicit passages. Once again carefully designed training based on the strategies employed by successful students resulted in study and recall improvements for the less successful students on all passages.

The work of Brandsford, Franks and their colleagues provides evidence that training based on cognitive activities of successful students resulted in improvement of less successful students. It also suggest that one attribute of successful (intelligent) students is the spontaneous

acquisition of accurate and useful metacognitive abilities.

What can we say after reading all of this material? First, there has been a great deal of progress in the area of metacognition. We have gone from an atheoretical investigation of discrete skills to a theory of intelligence and intellectual development.

Second, the findings do have direct application. From our review of the educational interventions already reported it is obvious that the field of psychology has begun to recognize this potential for educational application.

Third, we believe there is real potential for teachers adopting metacognitive knowledge in direct instructional programs. Taylor, (1983) for instance promises a wide variety of suggestions which include having children (1) estimate their performance and then compare this estimate to actual performance, (2) keep records of prediction accuracy and (3) learn strategies and their relative efficiency. At a rather simple level, teachers could help students learn about their own capabilities. Have any of you ever had a teacher sit down with you and discuss their evaluation of your cognitive strengths or weaknesses?

I also think that by paying attention to their students metacognitive abilities (particularly those used by better students) they can improve their own teaching. I want to provide two specific examples of how this can work using my daughter as a model. When Susan was in first grade her teacher was having difficulty teaching Nancy to count without overtly

using her fingers. After much effort the teacher began berating Nancy and made her life quite miserable. Finally, she threw up her hands and asked the class if anyone could help Nancy. Susan spent 5 minutes with Nancy and she never overtly used her fingers again. What did Susan do? She simply told Nancy to imagine her fingers in her head. She told Nancy that eventually she would no longer need to imagine. I know of many children who overtly use their fingers when counting. I have never heard a teacher give Susan's advice.

Later when Susan began spending time at night on homework we often heard her reading to herself out loud. As good parents we thought she might have some severe problem. Before rushing out for professional help, however, we decided to ask her why she was doing it. She replied that she had learned through experience that reading school assignments (never books she read for fun) out loud forced her mind to attend to what she was reading. When reading school assignments silently, her mind sometimes forgot what she was reading.

Students do attend to their own cognitive processes. They would attend more if instructed to do so. Teachers should also attend to how their students learn and if they do so they may be able to help other students learn.

Finally, what is the future direction this research should take? First, there needs to be more theoretically based research attempting to link metacognitive research to other cognitive theories (e.g., Piaget, self concept, and attribution theories). Although there have been some initial efforts

(e.g., Borkowski, Peck, Reid and Kurtz, 1983) much more needs to be done. Other suggestions include (1) additional studies of successful learners, (2) branching out from memory/reading to other areas, (math, problem solving, social skills, decision making), (3) developing psychometrically sound measures so that these measures of "metacognition" can be equated across studies and finally, (4) studying situational variables and allowing for generalization in an ecologically sound environment.

In conclusion, I believe this is an important area with a long and promising future.

References

Baddeley, A.D. (1976). The Psychology of Memory Basic Books, Inc., Publishers; New York.

Borkowski, J.G. and others. (1983). Impulsiviity and strategy transfer: metamemory as mediator. Cognitive Development. 54. 459-473.

Bransford, J.D., and others. (1982). Differences in approaches to learning: An overview. Journal of Experimental Psychology. 111. 390-398.

Bransford, J.D., and others. (1982). Differences in the precision of Self-Generated Elaborations. Journal of Experimental Psychology. 4. 399-405.

Bransford, J.D., and others. (1982). Differences in judgments of learning difficulty. Journal of Experimental Psychology. 4. 406-413.

Brown, R., McNeill, D. (1966). The "tip of the tongue" phenomenon. Journal of Verbal Learning and Verbal Behavior 5. 325-337.

Brown, A.L., Smiley, S.S. (1977). Rating the importance of structural units of prose passages: A problem of metacognitive development. Child Development. 48. 1-8.

Brown, A.L., Barclay, C.R. (1976). The effects of training specific mnemonics on the metamnemonic efficiency of retarded children, Child Development. 47. 71-80.

Campione, J.C., Brown, A.L., Ferrara, R.A. (1982). Mental

retardation and intelligence. In R. Sternberg (Ed.) Handbook of Human Intelligence. 8. 392-490. Cambridge University Press, New York.

Cavanaugh, J.C., Borkowski J.G. (1980). Searching for metamemory-memory connections: A developmental study. Developmental Psychology. 16. 441-453.

Cavanaugh, J.C., Perlmutter, M. (1982). Metamemory: A critical examination. Child Development. 53. 11-28.

Dember, W.N., Jenkins, J.J. (1970). General Psychology: Modeling Behavior and Experience. Englewood Cliffs, N.J.: Prentice-Hall.

Doctrow, M., Wittrock, M.C., Marks, C. (1978). Generative processes in reading comprehension. Journal of Educational Psychology. 70. 109-118.

Fabricius, W. V., Hagen, J.W. (1984). Use of causal attributions about recall performance to assess metamemory and predict strategies memory behavior in young children. Developmental Psychology. 20. 975-987.

Flavell, J.C., Wellman, H.M. Metamemory. In R.V. Karl, Jr. and J.W. Hagen (Eds.), Perspectives on the development of memory and cognition. Hillsdale, N.J.: Earlbaum, 1977.

Flavell, J.H., Fredericks, A.G., Hoyt, J.D. (1980). Developmental Changes in memorization processes. Cognitive Psychology. 1. 324-340.

Flavell, J.H., and Others. (1981). The Developmennt of comprehension monitoring and knowledge about communication.

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Franks, J.J., and others. (1982). Learning from explicit versus implicit texts. Journal of Experimental Psychology. 4. 414-422.

Kreutzer, Leonard, Flavell. (1975) An interview study of children's knowledge about memory. SRCD Monograph.

Hale, G.A. (1983). Students' predictions of prose forgetting and the effects of study strategies. Journal of Educational Psychology. 75. 708-715.

Hart, J.T. (1965) Memory and the feeling of knowing experience. Journal of Educational Psychology. 56. 208-216.

Kelly, M., and others. (1976). Relations among memory, memory appraisal, and memory strategies. Child Development. 47. 648-659.

Kurtz, B.E., Reid, M.K., Borkowski, J.G. (1982). On the reliability and validity of children's metamemory. Bulletin of the Psychonomic Society. 19. 137-140.

Kurtz, B.E., Borkowski, J.G. (1984). Children's metacognition exploring relations among knowledge, process and motivational variables. Journal Experimental Child Psychology. 37. 335-354.

Lackman, J.L., Lackman, R., Thronesbery, C. (1979). Metamemory through the adult life span. Developmental Psychology. 15. 543-550.

Lodico, M.G., and others (1983). The effects of

strategy-monitoring training on children's selection of effective memory strategies. Journal of Experimental Child Psychology, 35. 263-277.

Markman, E.M. (1977). Realizing that you don't understand: a preliminary investigation. Child Development, 48. 980-992.

Markman, E.M. (1979). Realizing that you don't understand: Elementary School Children's awareness of inconsistencies. Child Development, 50. 643-655.

Meyers, M., Paris, S.G. (1978). Children's metacognitive knowledge about reading. Journal of Educational Psychology, 70. 680-690.

Moely, B.E., and others. (1969) Production deficiency in young children's clustered recall. Developmental Psychology, 1. 26-34.

Moynahan, E.D. (1973). The development of knowledge concerning the effect of categorization upon free recall, Child Development, 44. 238-246.

Moynahan, E.D. (1976). The development of the ability to assess recall performance. Journal of Experimental Child Psychology, 21. 94-97.

Nelson, T.O., and others. (1982). Overlearning and the feeling of knowing. Journal of Experimental Psychology: Learning, Memory, and Cognition, 8. 279-288.

Nermack, E., Slotnick, N.S., Ulrich, T. (1971) Development of memorization strategies, Developmental Psychology, 5.

427-432.

O'Sullivan, J.T., Pressley, M. (in press). Completeness of instruction and strategy transfer, Journal of Experimental Child Psychology.

Paris, S., Cross, L. (in press) Informed strategies for learning: A program to improve children's reading awareness and comprehension. Journal of Educational Psychology.

Palincsar, A.S., Brown, A.L. (in press). Reciprocal teaching of comprehension fostering and monitoring. Cognition and Instruction.

Pressley, M., Borkowski, J.G., O'Sullivan, J.T. (1984). Memory strategy instruction is made of this: metamemory and durable strategy use. Educational Psychologist. 19. 94-107.

Pressley, M., Levin, J.R., Ghatala, E.S. (1984). Memory strategy monitoring in adults and children. Journal of Verbal Learning and Verbal Behavior. 23. 270-288.

Salatas, J., Flavell, J.H. (1976). Behavioral and metamnemonic indicators of strategic behaviors under remember instructions in first grade. Child Development. 47. 81-89.

Taylor, N.E. (1983). Metacognitive Ability: A curriculum priority. Reading Psychology. 4. 269-278.

Wellman, H.M. (1977). The Early development of intentional memory behavior. Human Development. 20. 86-101.

Wellman, H.M, and others. (1981). Understanding the combination of memory variables: Developing conceptions of memory limitations. Child Development. 52. 1313-1317.

Yarney, A.D., (1973). I recognize your face but I can't remember your name: further tip-of-the-tongue phenomenon. Memory and Cognition. 1. 287-290.

Yussen, S.R., Levy, V.M.,Jr. (1975). Developmental changes in predicting one's own span of short-term memory. Journal of Experimental Child Psychology. 19. 502-508